

Low-Mass Planar Photonic Imaging Sensor

Completed Technology Project (2013 - 2014)



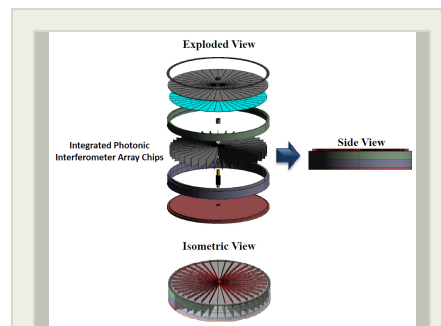
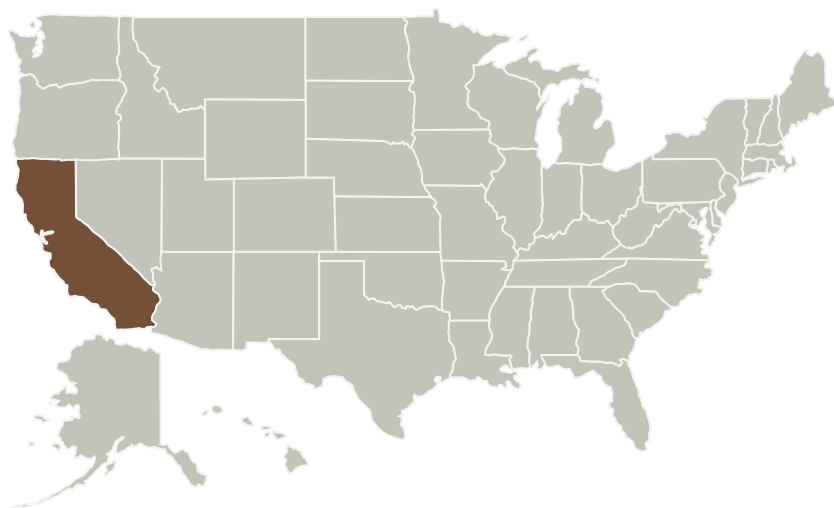
Project Introduction

We propose a revolutionary electro-optical (EO) imaging sensor concept that provides a low-mass, low-volume alternative to the traditional bulky optical telescope and focal plane detector array. This imaging sensor concept consists of millions of direct detection white-light interferometers densely packed onto photonic integrated circuits (PICs) to measure the amplitude and phase of the visibility function at spatial frequencies that span the full synthetic aperture.

Anticipated Benefits

This technology replaces the traditional optical telescope and digital focal plane detector array with a densely packed interferometer array based on emerging photonic integrated circuit (PIC) technologies that samples the object being imaged in the Fourier domain (i.e., spatial frequency domain), and then reconstructs an image. This approach replaces the large optics and structures required by a conventional telescope with PICs that are accommodated by standard lithographic fabrication techniques (e.g., CMOS fabrication). The standard EO payload integration and test process which involves precision alignment and test of optical components to form a diffraction limited telescope is, therefore, replaced by in-process integration and test as part of the PIC fabrication that substantially reduces associated schedule and cost.

Primary U.S. Work Locations and Key Partners



Concept Diagram

Table of Contents

Project Introduction	1
Anticipated Benefits	1
Primary U.S. Work Locations and Key Partners	1
Project Transitions	2
Organizational Responsibility	2
Project Management	2
Technology Maturity (TRL)	2
Images	3
Project Website:	3
Technology Areas	3
Target Destination	3

Low-Mass Planar Photonic Imaging Sensor

Completed Technology Project (2013 - 2014)



Organizations Performing Work	Role	Type	Location
University of California-Berkeley(Berkeley)	Lead Organization	Academia	Berkeley, California
Lockheed Martin Inc.	Supporting Organization	Industry	Palo Alto, California
University of California-Davis(UC Davis)	Supporting Organization	Academia	Davis, California

Primary U.S. Work Locations

California

Project Transitions

September 2013: Project Start

June 2014: Closed out

Closeout Summary: The Low-Mass Planar Photonic Imaging Sensor is based on the Segmented Planar Imaging Detector for EO Reconnaissance (SPIDER) concept developed in collaboration with Lockheed Martin Advanced Technology Center. SPIDER replaces the traditional optical telescope and digital focal plane detector array with a densely packed interferometer array based on emerging photonic integrated circuit (PIC) technologies that samples the object being imaged in the Fourier domain (i.e., spatial frequency domain), and then reconstructs an image. This approach replaces the large optics and structures required by a conventional telescope with PICs that are accommodated by standard lithographic fabrication techniques (e.g., CMOS fabrication). The standard EO payload integration and test process which involves precision alignment and test of optical components to form a diffraction limited telescope is, therefore, replaced by in-process integration and test as part of the PIC fabrication that substantially reduces associated schedule and cost. Our final report covers the details of the Low-Mass Planar Photonic Imaging Sensor Concept and supports the discussions by presenting a prototype PIC that was developed under a DARPA funded effort. Then a SPIDER design tailored to a Europa mission is presented to show the improvements over a conventional Topographical Imager (TI), in which SPIDER collects 10× the area on the surface of Europa with 17× the resolution. The choices for PIC material platforms are investigated and specific designs for waveguides and integrated optical components are presented. SPIDER image modeling and reconstruction algorithms are explained and image simulations shown. Then initial experimental data from a prototype PIC are presented and discussed before a SPIDER technology roadmap is introduced.

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

University of California-Berkeley (Berkeley)

Responsible Program:

NASA Innovative Advanced Concepts

Project Management

Program Director:

Jason E Derleth

Program Manager:

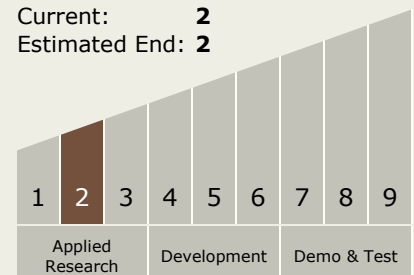
Eric A Eberly

Principal Investigator:

Ben Yoo

Technology Maturity (TRL)

Start: 2
Current: 2
Estimated End: 2

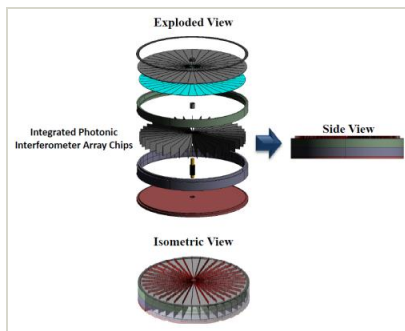


Low-Mass Planar Photonic Imaging Sensor

Completed Technology Project (2013 - 2014)



Images



Low-Mass Planar Photonic Imaging Sensor Concept

Concept Diagram

(<https://techport.nasa.gov/image/102260>)

Project Website:

<https://www.nasa.gov/directorates/spacetech/home/index.html>

Technology Areas

Primary:

- TX08 Sensors and Instruments
 - └ TX08.1 Remote Sensing Instruments/Sensors
 - └ TX08.1.1 Detectors and Focal Planes

Target Destination

Earth